

Description of Analytic Tools

1) **Name** - UPlan Land Use Allocation Model

2) **Author** – Professor Robert Johnson, UC Davis

3) **Technical support**

UPlan has a well written (cookbook style) 24 page user manual. Robert Johnson and his staff have offered to spend a little time with staff on training with the model.

4) **Categories** – Projecting urban land use patterns

5) **Main Features and Capabilities**

UPlan is a user-driven expert decision-rule model to project urban growth. This model uses various input GIS layers that are used with user input on various factors to project urban growth, including what kind of urban, where, and how much. It operates at a county level, developing a GIS layer of projected urban land use. It does not use time as an input, it uses population (ie population for the year 2030) and other pertinent layers and factors. It is a relatively easy-to-use tool (for the experienced GIS operator) to develop a compare scenarios using different user input.

6) **Applications**

UPlan has been implemented in California, New Mexico, Pennsylvania, New Jersey, and Utah. UC is currently attempting to develop all the GIS layers required to be able to be used on all counties of the State. The Merced Co. Assoc. of Governments is using UPlan in a USEPA/Caltrans national demonstration project to engage in environmental planning as part of a regional transportation plan.

7) **Calibration / Validation / Sensitivity Analysis**

UPlan requires no calibration. It wasn't developed based on historic information. It uses user input and various GIS layers to develop the projected urban land use patterns.

8) **Peer Review**

Unclear if there has been peer review. The model and results have been published.

9) **Anatomy of UPLAN:**

a) Conceptual Basis

The model operates on the principal that adding new population to an area will require additional land for residential, commercial, and industrial activities.

b) Theoretical Basis

Population increases will convert land from other non-urban uses to urban uses based on how much land is needed is based on in-fill in existing urban areas, housing density, and the amount of commercial and industrial activities needed for this population increase.

Where this increase in acreage occurs is based on attractions (freeways, main arterial, Cities' sphere of influence, rail stations, airports, etc.), discouragements (wetlands, open space, farmlands, etc.), and exclusions (existing developed urban, rivers, lakes, extreme slopes, etc.). The county general plans also can factor in where development could occur.

c) Numerical Basis

The first step in the model is to determine how many acres for each urban land use is required for the increased population. This is a calculation based upon user input. For residential, required are the expected persons per household, the percent of households in each housing density class, and the average parcel sizes for each density class. For commercial and industrial, required are number of workers per household, the percent of workers in each employment class, and the average area per worker.

The above relatively easy calculations are run and the results are the acreage demanded for each urban land use type. This information is used with the GIS coverage to allocate this acreage within the study area.

For allocations, the model operates using grids, not vector coverage. There are a multitude of grid coverage used in this model, the main ones are the attraction grids, the discouragement grids, and the exclusion grids. Every attractive and discouragement grid gets a weighting factor assigned to it by the user. For instance, freeway on-ramps is a grid that may be assigned a high weighting factor because it is assumed that on-ramps are very attractive to commercial development. Prime farmlands is a discouragement grid that may be assigned a high weighting factor by the user because they assume that development on prime farmland is a unwanted development by planning agencies.

In addition to weighting factors, the user can assign a buffer around each attraction and discouragement grid, assigning different weighting factors to each buffer.

The exclusion grids do not need modifications by the user. Exclusions (land where urban growth will not occur) include the grids of excessive slopes, lakes, rivers, etc.

Once the user provides all this input, the model overlays the attractions, discouragement, and exclusion grids creating a new grid. Each cell (50 meters by 50 meters) in the grid has a value which is developed for the values in the overlay grids. The excluded areas are given the value “no data”, the remaining areas are calculated by adding all the values from the attraction (positive numbers) and discouragements (negative numbers) grids. The resulting grid is a spatial representation of where development won’t occur (cells with “no data”) and where it could develop with a likelihood being the value of the area (a suitability grid). A cell value of 10 would mean it would be more likely to be developed than a value of 1.

This suitability grid is overlaid with the general plan grid to create a new grid to further isolate where development can occur (and what kind of development). The user has control over how the general plan grid can restrict allocations, including strict compliance to the plan to no compliance to the plan (and two levels in between).

The model then begins allocating urban development by type, beginning with the cells with the highest cell values. It continues until all the acreage is allocated, resulting a final grid showing where and how much each urban land use type would be developed given the use input.

d) Input and Output Data

Input data is explained above. The demographics data will need to be developed by the user for each area. The required grids may or may not be developed by UC, and may require development by the user.

Specific residential **input** includes:

- Base population
- Future population
- Persons per household
- Percent residential in high/medium/low/very low densities
- Average lot size
- Employees per household
- Percent vacancy

Specific employment **inputs** include:

- Percent employment in industrial/high density commercial/low density commercial

- Average square foot per employee for industrial/commercial high/commercial low
- Floor area ratio for industrial/commercial high/commercial low

For the attraction and discouragement layers, the user must input for each existing layer the amount of buffers and their distances. The user also must estimate the weighting for each buffer/layer.

Attraction grids include:

- Freeway ramps
- Highways
- Major arterials
- Minor arterials
- Sphere of influence
- Blocks with growth
- Existing urban

Discouragement grids include:

- Wetlands
- Floodplains
- Prime farmlands

Mask grids include:

- Rivers
- Lakes
- Existing Urban
- Flood Plains
- Public land

Output data includes:

- A grid of projected urban development by urban type
- Excel file containing the acreages by urban type

e) Data management

GIS coverages are managed within ARCVIEW. Input data from the user (buffers and weighting factors) are entered by the user in typical Windows GUI.

f) Software

The model is programmed in ARCVIEW 3.2, using the Avenue programming language, and uses the ARCVIEW extension Spatial

Analyst. All are products of ESRI. ARCVIEW 3.2 is no longer sold by ESRI. However, almost all the GIS world has ARCVIEW 3.2 available to them.